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May 8, 2013

Kathleen Clarke, Director
Governor's Public Land Policy Office
5110 State Office Building
P.O. Box 141107
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Dear Kathleen,

Thank you for the opportunity to review your February 14, 2013, Conservation Plan for Greater Sage-Grouse in Utah (Plan). We recognize the significant efforts that have gone into preparation of this Plan, beginning with the formation of the Governor's Work Group in February 2012. Prior to that, substantial greater sage-grouse conservation efforts have been implemented by Utah and its federal, state, local, and tribal partners, including pinyon-juniper removal, sagebrush restoration, and seeding projects. As described in your Plan (section 5.4), the Watershed Restoration Initiative partners have enhanced or restored over 382,000 acres of greater sage-grouse habitats statewide. Utah and its partners have also focused efforts on surveys and monitoring of this species, which has provided us with population and habitat information to help guide conservation efforts.

It is obvious that the emphasis of your Plan is to continue to contribute toward conservation of the greater sage-grouse. Your Plan's strengths lie in its ambitious goals and objectives to protect habitat which provides for the year-round life-cycle needs of the species, perpetuate conditions necessary to ensure recruitment of a continuing population within the aggregate state population, and enhance or improve sage-grouse habitat through restoration or rehabilitation activities. The Plan's objectives identify increasing sage-grouse numbers and maintaining viable populations within the eleven identified sage-grouse management areas (SGMA); annually protecting (e.g., leases, easements) 10,000 acres of sage-grouse habitat on private and State Trust Lands; enhancing 25,000 acres of sage-grouse habitat in the SGMAs annually; and managing opportunity areas to increase sage-grouse habitat acreage by an average of 50,000 acres per year. Substantial partnerships and funding will be required to implement this Plan, much of which is already in place through the Watershed Restoration Initiative, its umbrella Utah Partners for Conservation Development program, and the Greater Sage-Grouse Local Working Groups.

A number of the provisions in your Plan that address the threats faced by greater sage-grouse are well grounded in established management practices and the scientific literature. For example, we believe your Plan (sections 5.1, 5.2, and 5.4) correctly emphasizes planning for wildfire, invasive species, and vegetation management, including: 1) the proposed establishment of a statewide fire agency to eliminate jurisdictional boundaries and allow for immediate response to natural fires, 2) the proposed allocation of a high level of resources for fire response, restoration, and ongoing research efforts, 3) the need to aggressively contain and suppress invasive plant species infestations, and 4) active restoration and reclamation efforts of sage-grouse habitat through sagebrush and pinyon-juniper treatment actions. Your

Plan (section 5.3) also follows a valid, step-wise approach toward predator management, with an emphasis on restoring habitat conditions to reduce the effectiveness of predators, while considering predator control on a localized basis only as needed. We also agree that the voluntary incentive-based programs emphasized by your Plan (section 3.7.1) can be an important component of greater sage-grouse conservation efforts in the State (see Attachment—Voluntary Nature of Actions Proposed on Non-Federal Lands for further discussion).

Your Plan's management protocol (section 6.0) establishes a tiered approach for resolving impacts to sage-grouse habitat which we support—avoidance, minimization, and mitigation. Your proposed mitigation ratio of 4:1 (sections 6.5.1.1 – 6.5.1.3) is appropriate given that your Plan states the mitigation must be considered successful before the proposed disturbance occurs. We also strongly agree that the use of mitigation banks (Plan, section 6.4.1) can be an effective tool to provide landscape level conservation for this species as long as the banks are used in a manner that effectively offsets impacts to the specific SGMAs and habitat types that are impacted.

While there is much about your Plan that we support and that should be implemented as soon as feasible, we also believe there are elements that need further clarification or refinement in order for the Plan as a whole to be consistent with the Greater Sage-Grouse Conservation Objectives Team Final Report (COT report). Our purpose for working together with the States to develop the COT report was to provide objectives that, if met, would indicate the species is conserved and does not need federal protection under the Endangered Species Act. We are hopeful that this information will be useful to us in our 2015 listing decision and to States and other partners in the current development of conservation actions and strategies. It is for this reason that our review of your Plan (see Attachment) is provided largely in the context of the COT report.

In our review we continue to identify five primary outstanding items that we recommend be further considered in light of the COT report and available literature as you move forward with your Plan. We discuss these issues in the Attachment to this letter. We have previously discussed these items with you in meetings and email communications dated November 13, 2012; November 20, 2012; and December 14, 2012. However, we reiterate and expand upon our analyses of these items in the Attachment to help continue the collaborative and iterative process we have been engaged in with you. We see this review as an important "check-in" and continuation of that process to ensure your Plan is ultimately best positioned to contribute to a future where listing the greater sage-grouse under the Endangered Species Act is unnecessary. We believe that the incorporation of our recommendations, as provided in the Attachment, will further strengthen Utah's Greater Sage-Grouse Conservation Plan and ensure long-term viability for the species in the State.

Thank you for your continued coordination with us while you refine and implement this Plan. Please contact me 801-975-3330 (ext. 126) or Laura Romin (ext. 142) if we can be of further assistance.

Sincerely,

Larry Crist
Utah Field Supervisor

Attachment

cc: Juan Palma, State Director, Bureau of Land Management, Utah State Office
Marlene Finley, Deputy Regional Forester, U.S Forest Service Intermountain Region

ATTACHMENT

We would like to emphasize that our comments are intended to continue the collaborative process in which we are engaged and provide you with ongoing feedback as you refine and implement your Plan. We have identified the following areas as topics that we can assist you in ongoing planning efforts for conservation of greater sage-grouse in Utah.

Anthro and West Tavaputs Greater Sage-Grouse Populations

Your Plan (section 3.0) includes management and conservation of greater sage-grouse populations in eleven SGMAs distributed statewide, supporting greater than 90 percent of the Utah population of the bird. The conservation of a large percentage of the Utah population of the greater sage-grouse contributes toward meeting the COT report's (pages 12-13) guiding concepts of meeting redundancy, representation, and resiliency of the species.

However, as we have previously discussed with you, and as identified by your Plan, most sage-grouse populations in Utah are small and naturally fragmented. The majority of the SGMAs in Utah individually comprise less than 3 percent of the statewide population of greater sage-grouse. Because of the small, fragmented nature of Utah's greater sage-grouse populations, we recommend evaluating all sage-grouse populations and SGMAs for their ability to help conserve sufficient population and habitat connectivity, particularly in areas where information suggests movement of birds between areas.

In particular, we have previously discussed with you our concerns regarding the importance of the Anthro and West Tavaputs sage-grouse populations. Although the COT report does not include these populations as Priority Areas for Conservation (PAC)[1], we recommend that these populations be given additional consideration for protection due to their potential importance on a landscape level. The COT report (page 36) concludes that sage-grouse habitats outside of the PACs may be essential, by providing connectivity between PACs (genetic and habitat linkage), habitat restoration and population expansion opportunities, and flexibility for managing habitat changes that may result from climate change. The COT report also states that there may be seasonal habitats outside of PACs essential to meeting the year-round needs of sage-grouse within PACs but that have not yet been identified. Overall, the COT report encourages that important habitats outside of PACs be conserved to the extent possible, including minimization and mitigation of impacts.

The locations of the Anthro Mountain and West Tavaputs sage-grouse populations appear to be situated such that they provide connectivity between each other, populations of sage-grouse that occur on Ute tribal lands, and populations of sage-grouse in the Carbon SGMA. In particular, sage-grouse from Anthro Mountain have shown large seasonal movements of approximately 30 miles to Emma Park (Carbon SGMA), 18 miles to Whitmore Park (Carbon SGMA), and 18 miles between Anthro Mountain and West Tavaputs. There is also a documented occurrence of a bird moving from West Tavaputs to the Ute tribal lands (CaCoARM 2006, UBARM 2007,

[1] Throughout this letter we assume that PACs, and associated recommended conservation measures, described by the COT report are synonymous with the SGMAs identified by your Plan.

Gruber 2012, Robinson and Chi 2012). Although there are no SGMAs on Ute tribal lands, we recommend that you consider the conservation importance and maintenance of populations in this area, and the ability of your designated SGMAs to help support conservation of birds on Ute tribal lands. Migratory movements of sage-grouse are likely important for maintaining genetic diversity and overall population viability. Therefore, the Anthro Mountain and West Tavaputs areas may be important for overall viability of the northeastern Utah sage-grouse populations.

We realize that your decision to omit the Anthro Mountain and West Tavaputs areas from SGMA status is partly due to future energy development. We acknowledge that both areas have oil and gas leases that are likely to be developed, however large portions of these areas remain undeveloped. Habitat fragmentation resulting from land use activities such as energy development was one of the primary threats considered in our 12-month finding (75 FR 13910, March 23, 2010). Research on the impacts of energy development on sage-grouse has provided valuable information on how to minimize impacts using seasonal and spatial buffer restrictions. Given the limited amount of development that has currently taken place in these areas, we recommend that you evaluate and incorporate opportunities to proactively manage energy development and ensure species conservation in these areas.

In summary, we believe that the Anthro and West Tavaputs greater sage-grouse populations are important for habitat and population connectivity in northeastern Utah. We strongly recommend that you include these areas as SGMAs in your Plan, thereby allowing for the conservation of greater sage-grouse in light of projected energy development. We believe that the conservation of these areas, in addition to the 90 percent of greater sage-grouse already included in your SGMAs, will fully support the COT report's conservation goal (page 13) to maintain viable, connected, and well distributed populations and habitats of greater sage-grouse across the species' range. We will also continue to work with the Bureau of Land Management and U.S. Forest Service through their planning efforts to consider these areas for the long-term conservation of the greater sage-grouse.

Voluntary Nature of Actions Proposed on Non-Federal Lands

Your Plan (sections 3.7.1- 3.7.3, 4.1, 6.0) emphasizes the role of private landowner incentives in greater-sage grouse conservation and relies entirely on voluntary conservation efforts for preservation of greater sage-grouse on non-federal lands. It identifies five SGMAs (Box Elder, Parker Mountain-Emery, Rich-Morgan-Summit, Strawberry, and Uintah) as focal points for state and local efforts to obtain incentive-based negotiated covenants, easements, leases, or other legal instruments necessary for sage-grouse conservation on private lands[2].

We strongly support voluntary incentive-based programs as important components of species' conservation efforts. Voluntary efforts provide flexible tools for landowners that can promote species' conservation while allowing continued economic uses of private lands. The COT report (pages 33-34) highlights the importance of incentive-based conservation actions in developing a

[2] These SGMAs are identified in part because they contain the highest percentage of private lands. As described above, the Carbon SGMA contains 82 percent private or other non-federal lands (Plan, appendix 5), and should also be considered a focal point for incentive-based conservation efforts.

conservation strategy but also recommends the use of both regulatory mechanisms and incentive based actions to address all threats within the SGMAs to the maximum extent practicable.

In some cases, proactive, voluntary conservation efforts, as prescribed by your Plan, can substantially reduce threats to a species. However, dependence on voluntary conservation actions places a greater burden of proof on the State to demonstrate their intended effectiveness. Because your Plan relies entirely on voluntary measures for conservation of sage-grouse on non-federal lands, it will be especially important that you can demonstrate that landowners will participate in these programs to a meaningful degree. As you implement the voluntary components of your Plan, it will also be important that you clearly document the funding mechanisms, implementation, and effectiveness of all incentive-based conservation measures and their ability to conserve greater sage-grouse on a landscape level. Clear documentation will help us evaluate the effectiveness of your Plan's voluntary measures in our 2015 listing decision, in accordance with our Policy for Evaluation of Conservation Efforts When Making Listing Decisions; 68 FR 15100, March 28, 2003 (see COT report, page 33).

In keeping with recommendations of the COT report, we also recommend continued consideration of local land use regulations and policies. Almost 60 percent of occupied greater sage-grouse habitat in Utah and 40 percent within the SGMAs occurs on non-federal lands, constituting a substantial portion of greater sage-grouse populations state-wide. Given the large proportion of greater sage-grouse populations on non-federal lands in your SGMAs, it is not clear how successful the complete reliance on voluntary incentives will be for greater sage-grouse conservation in the State. A combined approach of voluntary and specific regulatory actions has the potential to provide greater certainty for greater sage-grouse conservation.

The Amount of Surface Disturbance Expected

Your Plan (sections 6.5.1.2 and 6.5.1.3) states that cumulative new permanent disturbances should not exceed 5 percent of the surface area of habitat within each SGMA under certain circumstances (section 8.1). "Certain circumstances" is not defined. As we have previously discussed with you, we recommend that the 5 percent disturbance cap be applied to all SGMAs in all circumstances, and include all existing disturbances (including natural disturbances such as wildfire) because: 1) major developed areas, and even areas projected for development (e.g. oil and gas development) were already removed from the SGMA boundaries, resulting in smaller SGMAs more prone to the effects of existing and ongoing development, and 2) our best available information indicates that total (i.e., existing and new) surface disturbance levels should be 5 percent or less to conserve greater sage-grouse populations long-term. Some information such as the BLM's National Technical Team's (NTT) report recommends a 3 percent disturbance limit in priority sage-grouse habitats regardless of land ownership, which we recommend that you consider in your conservation planning efforts. Most sage-grouse leks are found in areas with ≤ 3 percent surface disturbance (Knick et al. 2013). If the surface disturbance cap does not include existing disturbances, it is likely that disturbance within some or all of the SGMAs will greatly exceed limits under which sage-grouse populations can remain viable.

In our previous discussions, you indicated that your inclusion of only new surface disturbances (not existing) in the 5 percent disturbance cap calculation is appropriate because your mitigation

protocol requires a 4:1 mitigation ratio and will accordingly result in the continued improvements of sage-grouse habitats and populations in all SGMAs regardless of existing or ongoing activities. However, given the high percentage of non-federal lands in the SGMAs with no regulatory mechanisms that would require mitigation, it is not clear that the 4:1 mitigation on federal lands would be sufficient to offset all impacts across the SGMAs to the point where sage-grouse populations and habitats do not decline (in accordance with the conservation objectives of the COT report).

In addition, mitigation is rarely 100 percent effective at re-creating suitable habitat conditions to support entire life cycles of a species. In fact, your Plan (section 6.4) states that effective mitigation does not require that birds are immediately present using the land, only that the habitat is capable of supporting birds as part of their yearly life-cycle. Therefore, it is possible that, despite mitigation efforts, the overall effect of continued habitat disturbances that could exceed 5 percent (i.e., including existing and new disturbances) will be declining populations. Therefore, we recommend that you maintain a cumulative disturbance cap that includes all existing and new disturbances within an SGMA.

Your Plan (sections 6.5.1.2, 6.5.1.3) also states that allowances will be made to include the temporal effects of any temporary disturbances. We interpret this statement to mean that temporary disturbances will not be included in the calculation of the 5 percent disturbance cap. Temporary disturbances are defined by your Plan (section 6.1.1) as any ground disturbing activities which last less than five years; and temporary disturbances do not need to be mitigated if the reclamation or restoration work is effective within the five year period. Because temporary disturbances may occur over an extended period of five years and cumulatively may amount to large acreages, we recommend that these disturbances be included as part of the percent surface disturbance cap calculation until they are successfully restored to suitable greater sage-grouse habitats.

Finally, your Plan (section 7.0) identifies that existing land uses, planned developments (currently under local or federal, i.e., NEPA, environmental review), and projects that have completed environmental review but are not yet built are recognized by the Plan, and shall not be affected by the Plan's implementation. Some of these projects include large-scale developments that would result in substantial acreage impacts to greater sage-grouse habitats. Although we anticipate that these projects will proceed, we recommend that they: 1) be "counted" toward the surface disturbance cap in the SGMA, and 2) incorporate additional greater sage-grouse minimization and mitigation measures as needed to offset unavoidable impacts.

In summary, we recommend that for all land use activities, all temporary and permanent existing and projected disturbances be measured and clearly tracked. We recommend that the cumulative effect of these activities results in less than 5 percent total surface disturbance in each SGMA.

Protection of Leks and Nesting Habitat

Your Plan (section 6.5.1.1) includes a management provision that excludes permanent disturbances within one mile of a lek, unless that disturbance is not visible to the sage grouse using the lek. This provision does not seem to be consistent with the COT report (pages 43-44),

which recommends avoiding energy development (e.g., permanent disturbances) in PACs. Where avoidance of PACs is not possible, the COT report recommends that: 1) development should only occur in non-habitat areas with an adequate buffer that is sufficient to preclude impacts to sage-grouse habitat from noise and other human activities, and 2) if development must occur in sage-grouse habitats due to existing rights and lack of reasonable alternative avoidance measures, then development should occur in the least suitable habitat for sage-grouse and be designed so there are no detectable declines in sage-grouse population trends (seeking increases in trends if possible).

Your Plan (section 3.1) indicates that 91 percent of greater sage-grouse hens in Utah nest within 3 miles of a lek[3]. Protection of sage-grouse nesting habitat is essential for population viability and is identified as an objective of your Plan (section 2.0)—to protect habitat which provides for the year-round life cycle needs of the species. We recommend the following buffers that are consistent with the BLM's NTT report be considered unless local information provides a compelling reason or justification for deviation:

- We recommend a minimum 1.0 mile buffer be placed on lek sites in which no structures or permanent surface disturbances should be authorized, without exception.
    - The fact that a tall structure is not visible from a lek does not infer that there will be no impacts to the greater sage-grouse population. Even if a tall structure is located behind a hill (i.e., not visible to the lek), it may still impact breeding or nesting birds that could utilize, but now avoid, habitats in the vicinity of the tall structure (Table 1).
- In priority habitats (i.e., habitat within your SGMAs), we recommend avoiding placement of tall structures within a 4 mile buffer of a lek. The intent of this buffer is to protect the lek and nesting habitat. Exceptions can be made for development of non-habitat areas within this buffer, only if it can be determined that the development will not have indirect impacts such as habitat fragmentation or bird avoidance of nesting areas. However, we recommend that wind energy developments never be placed within the 4 mile lek buffer (Table 1).

We acknowledge that the science of tall structure impacts to greater sage-grouse is still evolving. However, some negative effects have been reported (Table 1) including impacts on lek attendance from well sites and haul roads within 2-3 miles of a lek (Walker et al 2007, Johnson et al. 2011). Natural gas development within 0.6-3 miles of active greater sage-grouse leks may lead to declines in breeding populations, lower nest initiation, and lower annual survival of chicks (Lyon and Anderson 2003, Holloran 2005, Aldridge and Boyce 2007, Walker et al. 2007, Holloran et al. 2010). Likelihood of winter range use can decline at 80-acre well densities (Doherty et al. 2008, Hagen et al. 2011). Brood success and nest success of greater sage-grouse

[3] The NTT report recommends a 4 mile buffer to protect leks and nesting habitats. We have previously requested additional information regarding the State's recommended 3-mile buffer. In particular, we request information regarding whether the 3 mile buffer varies based on elevation or geographical differences between populations. Once we receive this information, we can help evaluate the NTT recommendations for tall structure avoidance, and the effects of using a 3 mile versus 4 mile buffer.

also declines closer to wind turbines (LeBeau 2012). In addition, time lags occur in which sage-grouse population declines may not occur until several years post-project developments (LeBeau 2012). This science supports our aforementioned recommended lek buffers of 1 mile and 4 miles for avoiding surface disturbances and tall structures.

In summary, we recommend avoiding permanent structures within a 4 mile lek buffer (see footnote 3 on the previous page) at all times. Exceptions may be appropriate for the placement of permanent structures on non-habitat areas within the 4 mile lek buffer if it can be determined that the location of these structures will not impact nesting sage-grouse.

Impacts of Transmission Lines

Your Plan (section 5.6) states that most existing utility corridors (pipelines, roads, major overhead electrical transmission lines) are well-defined at the present time, and this threat is seen as minimal. Because development of infrastructure results in habitat loss, fragmentation, and may cause sage-grouse habitat avoidance, we recommend avoiding any new transmission line corridors in SGMAs and relocating any corridors designated within SGMAs that have not yet been developed. For existing corridors with existing lines, we recommend that any new transmission lines be located as closely as possible to the existing line. This is consistent with the objectives outlined in the COT report (pages 43-44, 51) regarding reduction of threats posed by energy development and infrastructure.

Because your Plan does not consider the suite of long-term effects from transmission lines, you have also not provided a decision tree for the placement of new transmission lines or other infrastructure on the landscape. The COT report (page 51) outlines an objective for reducing the threat posed by infrastructure through a phased approach to siting transmission lines:

(1) Avoid construction of infrastructure (including transmission lines) in sage-grouse habitat, both within and outside of PACs;
(2) Transmission lines which cannot avoid PACs should be buried (if technically feasible), and disturbed habitat should be restored; and
(3) If avoidance is not possible, new structures should be consolidated with existing features, and should not result in a cumulative corridor width greater than 200 meters.

The COT report also recommends that when this development must occur in PACs, the impacts of these features to greater sage-grouse should be mitigated. Your Plan (section 5.6) concludes that research completed to date has not shown immediate impacts from existing power lines on nest or brood success. As a result, you recommend that management stipulations and conditions should focus on mitigating only the direct surface disturbance impacts from transmission lines.

While we acknowledge that literature on indirect impacts from transmission lines is inconclusive, there is evidence of impacts on greater sage-grouse (Ellis 1985, Braun 1998, Beck et al. 2006, Hagen et al. 2011, Knick et al. 2013) and lesser prairie chickens (a similar species) (Pitman et al. 2005, Pruett et al. 2006, Hagen et al. 2011), including direct mortality (collisions), avoidance behavior, lek relocation, reduced nesting, and overall reduced habitat use (Table 1). We encourage you to consider placing a buffer on the transmission corridor to address potential

indirect impacts. As an example, the Oregon Fish and Wildlife Department recommends a 0.6 mile buffer on each side of a transmission line to determine and mitigate for indirect impacts (Oregon Fish and Wildlife 2012). Based on available literature (Table 1), we conclude that Oregon Fish and Wildlife Department's recommendations are an appropriate way to evaluate the indirect effects of transmission lines.

In summary, we encourage you to add a stepwise decision tree for the avoidance, consolidation, and mitigation of direct and indirect impacts of transmission lines in the sage-grouse SGMAs, using the recommendations of the COT report and available literature as presented in Table 1 of this Attachment. At a minimum, we recommend that the evaluation and mitigation of indirect effects should include a 0.6 mile buffer perpendicular to both sides of transmission line corridors.

Table 1. Effects of Tall Structures on Greater Sage Grouse

Disturbance	Citation	Affect ?	Life Cycle/Behavior Affected	Affect Distance (mi)	Life Cycle/Behavior Not Affected
Wind	LeBeau 2012	Yes	Nest and brood survival	3 mi	Female survival Nesting and brood-rearing attempts
Transmission Lines	Knick et al. 2013	Yes	Habitat suitability highest where powerline densities <0.06 km/km2 Leks absent where powerline densities >0.20 km/km^2		
	Nonne et al. 2013[4]	No			Male survival and movement Female survival Pre-fledging chick survival Nest survival Nest distance from line
	LeBeau 2012	No			Nest success
	Hagen et al. 2011[5]	Yes	Collisions with lines Predation Avoidance	0.45 mi	

[4] Nonne et al. 2013 indicate that these are preliminary results. They plan to continue to investigate 1) the influence of distance to the transmission line on numerous sage-grouse demographics, 2) the influence of the transmission line on habitat use.

[5] Study on greater and/or lesser prairie chickens

	Johnson et al. 2011	No			Lek count trends not consistently related to the distance to nearest powerline or length of powerline within 11 mi.
	Pruett et al. 2009[1]	Yes	Avoidance[6]	.06 mi	
	Beck et al. 2006	Yes	Collisions with lines – adults and juveniles		
	Pitman et al. 2005[1]	Yes	Nest site selection	0.25 mi	
	Braun 1998	Yes	Habitat use	0.4 mi	
	Ellis 1985	Yes	Predation (golden eagles) Lek site, feeding, and loafing areas moved further from the line (affected dispersal patterns)	0.75 mi	

[6] Pruett et al 2009 indicates that their results are likely conservative because they only evaluated birds with home ranges that overlapped the transmission line feature. Therefore, there was a high probability of recording bird locations near the feature.

Oil/Gas	Kirol 2012	Yes	Reduced brood survival when total surface disturbance ≥4% within 0.35 mi of brood rearing habitat. 1 well within 0.37 mi of nest decreased probability of occurrence by 35%. Visual well density negatively correlated with female sage-grouse occurrence in nesting and early brood-rearing at 1-km^2 scale.	0.35 mi	
	Hagen et al. 2011[1]	Yes	Likelihood of winter range use reduced 10%	1 well/1.5 mi^2	
	Johnson et al. 2011	Yes	Lek count trends lower.	>10 wells within 3.0 mi or >160 wells within 11 mi	Johnson et al. 2011
	Holloran et al. 2010	Yes	Yearling males avoided leks and yearling females avoided nesting near infrastructure. Lower annual survival of chicks.	0.6 mi (yearling females)	

	Aldridge and Boyce 2007	Yes	Model predicted 1.5 times increase in risk for chick survival for each additional oil well visible within 1 km of brood locations.[7] Hens avoided nesting in edge-effect habitats (roads, well sites, urban habitat, and croplands combined).	1 km from brood locations	Nest success adjacent to edge-effect habitats (roads, well sites, urban habitat, and cropland combined).
	Holloran 2005	Yes	Lek – number displaying males declined. Yearling females avoided developed areas, nesting further away from roads. Brooding females avoided producing wells.	1.8 – 3.0 mi or 1 well/1.0 mi^2	

[7] Sage-grouse may be attracted to disturbed areas such as trails and well pads because these sites tend to harbor succulent invasive species (sink habitat).

	Lyon and Anderson 2003	Yes[8]	Nesting further from lek, and lower nest initiation.	N/A	
Coalbed Methane	Doherty et al. 2008	Yes	Winter Habitat – 80-acre spacing decreased the odds of sage-grouse use by 0.3 compared to the average landscape. Sage-grouse 1.3 times more likely to use winter habitat if development not present.	80-acre spacing	
	Walker et al. 2006	Yes	Lek – number displaying males and persistence Lag time from development to reaction from sage-grouse	0.5-2.0 mi	
Communication Towers	Knick et al. 2013	Yes	Habitat suitability highest where communication tower densities <0.01 km/km^2 Leks absent where communication tower densities >0.08 km/km^2		
	Johnson et al. 2011	Yes	Lek count trend negatively related to proximity to and numbers of communication towers within 11 miles		

[8] Lek was affected by proximity to a low-use (1-12 vehicles per day) road in the gas field – not an evaluation of tall structure effects. However, low-use roads are often ancillary facilities to energy developments and transmission lines.

LITERATURE CITED

Aldridge, C.L. and M.S. Boyce. 2007. Linking occurrence and fitness to persistence: habitat-based approach for endangered greater sage-grouse. Ecological Applications 17(2):508-526.

Beck, J.L., K.P. Reese, J.W. Connelly, and M.B. Lucia. 2006. Movements and survival of juvenile greater sage-grouse in southeastern Idaho. Wildlife Society Bulletin 34(4):1070-1078.

Braun, C.E. 1998. Sage-grouse declines in western North America: what are the problems? Proceeding of the Western Association of State Fish and Wildlife Agencies 78:139-156.

Castle Country Adaptive Resource Management Local Working Group (CaCoARM). 2006. Castle Country greater sage-grouse (*Centrocercus urophasianus*) local conservation plan. Utah State University Extension. Jack H. Berryman Institute and Utah Division of Wildlife Resources Unpubl. Rep. Salt Lake City, Utah. 80pp.

Doherty, K.E., D.E. Naugle, B.L. Walker, and J.M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Ellis, K.L. 1985. Effects of a new transmission line on distribution and aerial predation of breeding male sage grouse. Final report, Deseret Generation and Transmission Cooperative, Sandy, UT. 28 pp.

Gruber, N.W. 2012. Population dynamics and movements of translocated and resident greater sage-grouse on Anthro Mountain, Utah. Utah State University. M.S. Thesis. 127pp.

Hagen, C.A., J.C. Pitman, T.M. Loughin, B.K. Sandercock, R.J. Robel, and R.D. Applegate. 2011. Impacts of anthropogenic features on habitat use by lesser prairie chickens *in* Sandercock, B., K. Martin, and G. Segelbacher. Ecology, Conservation, and Management of Grouse. Berkley and Los Angeles, University of California Press. pp. 63-75.

Holloran, M.J. 2005. Greater sage-grouse (Centrocercus Urophasianus) population response to natural gas field development in western Wyoming. Dissertation, University of Wyoming, Laramie.

Holloran, M.J., R.C. Kaiser, and W.A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management 74(1):65–72.

Johnson, D.J., M.J. Holloran, J.W. Connelly, S.E. Hanser, C.L. Amundson, and S.T. Knick. 2011. Influences of environmental and anthropogenic features on greater sage-grouse populations, 1997-2007. pp. 407-450 *in* S.T. Knick and J.W. Connelly (editors). Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

Kirol, C. P. 2012. Quantifying habitat importance for greater sage-grouse (*Centrocercus urophasianus*) population persistence in an energy development landscape. M.S. Thesis. Department of Ecosystem Science and Management. March 5, 2012. 203 pp.

Knick, S.T., S.E. Hanser, and K.L. Preston. 2013. Modeling ecological minimum requirements for distribution of greater sage-grouse leks: implications for population connectivity across their western range, U.S.A. Ecology and Evolution. John Wiley & Sons, Ltd; publishers. 13 pp.

LeBeau, C. 2012. Evaluation of greater sage-grouse reproductive habitat and response to wind energy development in south-central, Wyoming, M.S. Thesis, Department of Ecosystem Science and Management, University of Wyoming, Cheyenne. August 2012. 120pp.

Lyon, A.G. and S.H. Anderson. 2003. Potential gas development impacts on sage grouse nest initiation and movement. Wildlife Society Bulletin 31:486-491.

Oregon Department of Fish and Wildlife. 2012. Implementing habitat mitigation for greater sage-grouse under the core area approach. March 20, 2012. Unpubl. report. 15pp.

Pitman, J.C., C.A. Hagen, R.J. Robel, T.M. Loughlin, and R.D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. Journal of Wildlife Management 69:1259-1269.

Pruett, C.L., M.A. Patten, and D.H. Wolfe. 2009. Avoidance behavior by prairie grouse: Implications for development of wind energy. Conservation Biology 23:1253-1259.

Robinson, J. and R. Chi. 2012. Emma Park, Anthro Mountain, and West Tavaputs greater sage-grouse populations conference call notes. November 4, 2012. In U.S. Fish and Wildlife Service Utah Ecological Services Field Office files. 4pp.

Sage Grouse National Technical Team (NTT). 2011. A Report on National Greater Sage-Grouse Conservation Measures. December 21, 2011. 74pp.

Uinta Basin Adaptive Resource Management Local Working Group (UBARM). 2006. Uinta Basin greater sage-grouse (*Centrocercus urophasianus*) local conservation plan. Utah State University Extension. Jack H. Berryman Institute and Utah Division of Wildlife Resources Unpubl. Rep. 93pp.

U.S. Fish and Wildlife Service. 2013. Greater sage-grouse (Centrocercus urophasianus) Conservation Objectives: Final Report (COT). U.S. Fish and Wildlife Service, Denver, CO. February 2013. 91pp.

Walker, B.L., D.E. Naugle, and K.E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.